NON-PUBLIC?: N
ACCESSION #: 8910120066
LICENSEE EVENT REPORT (LER)

FACILITY NAME: SAN ONOFRE NUCLEAR GENERATING PAGE: 1 OF 08
STATION, UNIT 2

DOCKET NUMBER: 05000361

TITLE: UNIT 2 MANUAL REACTOR TRIP DURING PLANNED SHUTDOWN TO APPROACH TO
CORE PROTECTION CALCULATOR AXIAL SHAPE INDEX AUXILIARY TRIP SETPOINT
EVENT DATE: 09/02/89 LER #: 89-019-00 REPORT DATE: 10/02/89

OTHER FACILITIES INVOLVED: NONE DOCKET NO:

OPERATING MODE: 1 POWER LEVEL: 027

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: H. E. MORGAN, STATION MANAGER TELEPHONE: (714)368-6241

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

At 0543 on September 2, 1989, during a planned shutdown of Unit 2 at the end of Cycle 4, a manual reactor trip was initiated due to the approach of axial shape index (ASI) to the Core Protection Calculator (CPC) auxiliary trip setpoint. ASI describes the axial power distribution of the reactor core. There is no safety significance to this event since the reactor protection system functioned in accordance with design.

At the end of a fuel cycle, the effect of a decrease in plant power on ASI is greater than at any other time in the cycle. As a result, strict controls must be employed to maintain ASI within limits and prevent a trip. Although action was taken to control ASI, it was not sufficient to maintain ASI within its limits. The guidance in the operating procedure

governing plant shutdown was not sufficiently specific to provide assurance that the operators could successfully control ASI during a plant shutdown at end-of-cycle.

An evaluation of this event was performed by the Core Analysis Engineering group. As a result of this evaluation, the above causes were determined and a proper strategy for end-of-cycle plant shutdowns was developed, which will be incorporated into the Plant Shutdown procedure. This event will be discussed with appropriate Operations personnel, and additional operator training on end- of-cycle ASI control will be included in the initial and requalification licensed training programs.

END OF ABSTRACT

Plant: San Onofre Nuclear Generating Station
Unit: Two
Reactor Vendor: Combustion Engineering
Event Date: 09-02-89
Time: 0543

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 1, Power Operations (27%)

B. BACKGROUND INFORMATION:

1. Axial Shape Index (ASI)

ASI describes the axial power distribution of the reactor core AC! and is defined as the difference between the average power produced in the lower half of the core and the average power produced in the upper half of the core, all divided by the sum of these two powers. Thus, with power equally distributed between the lower and upper halves of the core, ASI is equal to zero; with a power distribution skewed toward the top of the core, ASI is negative; and with power skewed toward the bottom of the core, ASI is positive.

2. Effect of Core Life and Reactor Power on ASI

At high power levels, the rise in temperature of the reactor coolant AB! across the core in conjunction with a negative moderator temperature reactivity coefficient (MTC) causes the bottom of the core, which is at a lower temperature, to produce

more power than the top of the core. The resultant increased depletion of fuel at the bottom of the core over the fuel cycle causes the power distribution to trend toward the top of the core. This trend is offset by MTC, which becomes more negative over the fuel cycle, in conjunction with the temperature rise across the core. At lower reactor powers at the end of the fuel cycle, with a resultant smaller temperature rise across the core, the axial power distribution tends to shift toward the top of the core, resulting in a negative ASI.

In addition, if the power distribution shifts to the top of the core during a decreasing power transient, the xenon concentration in the bottom of the core will, over several hours, increase relative to the top, exacerbating the axial power shift to the top of the core.

3. Core Protection Calculators (CPCs) and Core Operating Limit Supervisory System (COLSS)

Each of four CPC channels JC! receive input from the excore nuclear instruments IG! and perform an ASI calculation for use in providing the departure from nucleate boiling ratio (DNBR) and local power density (LPD) reactor protection trips. These trips are designed to prevent exceeding the specified acceptable fuel design limits (SAFDLs). At lower powers, with normal plant parameters, the margin to exceeding these SAFDLs is greater than at higher powers; therefore, a higher ASI could be tolerated at lower powers without exceeding a SAFDL.

When above 17% power, if the worst case ASI ("hot pin ASI") in the core is calculated by a CPC channel to be outside the tolerance of -0.5 to +0.5, that channel would generate an auxiliary trip. Auxiliary trips in two (of four) channels would result in a reactor trip. An auxiliary trip does not necessarily mean that an approach to a SAFDL is occurring. Both the core average ASI and the hot pin ASI values can be monitored on the digital readout of each CPC channel.

COLSS ID! receives input from the incore nuclear instruments and performs an ASI calculation. Due to the greater number and location of incore detectors as compared to excore detectors, the COLSS calculation of ASI is more accurate than the CPC calculation.

4. ASI Control

Control Element Assemblies (CEAs) AA! are either inserted into the core to cause ASI to become less negative or withdrawn from the core to cause ASI to become less positive. Guidance on use of CEAs to control ASI during power transients is provided in both the "Power Operations" and the "Plant Shutdown to Hot Standby" procedures. In order of preference, part-length, group 6, and group 5 CEAs may be utilized to control ASI. The use of group 5 CEAs for ASI control has been limited to lower powers.

5. Feedwater Control System (FWCS) Reactor Trip Override (RTO) Response

The FWCS JB! provides control grade signals to the main feedwater pump turbines (MFPTs) SJ, P, TRB!, main feedwater regulating valves (MFRVs) FCV, LCV!, and main feedwater bypass valves (MFBVs) FCV, LCV! to maintain steam generator (SG) SG! levels in the normal range. Following a reactor trip, the FWCS generates an RTO signal which causes: 1) the MFPT speed to decrease to the minimum control speed setting; 2) the MFRVs to close; and
3) the MFBVs to reposition to provide approximately 5% feedwater flow to the SGs.

C. DESCRIPTION OF THE EVENT:

1. Event:

At 0543 on September 2, 1989, during a planned shutdown of Unit 2 at the end of Cycle 4, a manual reactor trip was initiated from 27% power due to the approach of ASI to the CPC auxiliary trip setpoint.

Operators had initiated the shutdown on September 1, decreasing power from 82% (power had been lowered earlier in the day to perform a heat treatment of the circulating water system KE!) at a rate of approximately 5% per hour. During the power decrease to approximately 50% power, part length and group 6 CEAs were inserted to counteract the trend of ASI to become more negative. At this point, these two CEA groups had been inserted nearly to their power-dependent limits for ASI control. Since the use of group 5 CEAs for ASI control was

limited to lower powers, ASI was allowed to become more negative as the plant shutdown continued. Operators monitored core average ASI both on the CPCs and on COLSS in accordance with the procedure for plant shutdown and concluded that the trend in ASI would not interfere with the normal shutdown, which directs that a manual reactor trip be initiated at 15% power.

At 0245, with power at approximately 40%, the insertion of group 5 CEAs into the core for ASI control was initiated. ASI continued to become more negative, however, and with reactor power at 29% and CPC core average ASI at approximately -0.4 (COLSS ASI was approximately -0.27), a CPC channel D auxiliary trip actuated (hot pin ASI at -0.5) at 0507. Margin to the CPC DNBR and LPD trips still existed, indicating that an approach to a SAFDL was not occurring. Monitoring of the hot pin ASI values of the other CPC channels was initiated; these values were each slightly less negative than channel D. Group 5 and part length CEAs were inserted further, but ASI (still) continued to become more negative. CPC channel A hot pin ASI approached the auxiliary trip setpoint, and the operators manually initiated a reactor trip.

All CEAs were observed to completely insert into the core, and plant conditions were stabilized; however, the rod bottom indications for two CEAs were observed to lag behind the other CEAs by several seconds.

2. Inoperable Structures, Systems or Components that Contributed to the Event:

None

3. Sequence of Events:

TIME DATE ACTION

1900 9/1 Initiated power decrease (following circulating water system heat treatment).

Approx.
0100 9/2 Reactor power at approx. 50% with part length and group 6 CEAs utilized nearly to capacity for ASI control. Continued power

decrease, allowing ASI to become more
negative.

0245 9/2 Reactor power at approx. 40%; initiated use
of group 5 CEAs for ASI control.

0507 9/2 Received CPC channel D auxiliary trip due
to hot pin ASI exceeding trip setpoint.
Initiated monitoring hot pin ASI on all CPC
channels.

0543 9/2 Initiated manual reactor trip due to CPC
channel A hot pin ASI approach to trip
setpoint. Evaluated trip to be an
uncomplicated reactor trip.

4. Method of Discovery:

Refer to Section C.1, "Event".

5. Personnel Actions and Analysis of Actions:

During the power decrease, operators monitored core average ASI on the CPC channels and on COLSS. This was in accordance with the Plant Shutdown procedure.

Upon receiving the CPC channel D ASI auxiliary trip, initiated monitoring the hot pin ASI on each of the CPC channels. Initiation of a reactor trip was correctly determined not to be necessary (at this point) since the hot pin ASI on the other CPC channels indicated less negative than the -0.5 trip setpoint. Core average ASI indicated (by COLSS) approximately -0.27 at this time.

When the CPC channel A hot pin ASI approached its trip setpoint, the operators properly initiated a manual reactor trip; this is in accordance with the Plant Shutdown procedure.

Following the reactor trip, the operators stabilized plant conditions utilizing the Standard Post Trip Actions and Reactor Trip Recovery emergency operating instructions. MFPT 2K006 failed to automatically maintain a pump discharge pressure greater than SG pressure immediately following the trip (in response to the FWCS RTO signal), resulting in a loss of main

(normal) feedwater flow to the SGs. Operators promptly restored main feedwater flow by taking manual control of the MFPT speed controller to increase pump speed and discharge pressure. SG levels remained in the normal range, never decreasing to the emergency feedwater BA! actuation setpoint.

6. Safety System Responses:

The reactor protection system JC! functioned in accordance with design. CEA #57 and #81 rod bottom lights did not illuminate until approximately 14 seconds after the other CEA rod bottom lights; however, a review of the rod position data indicates that the above referenced CEAs did insert concurrently with the remainder of the CEAs. Similar occurrences have been seen previously and are indicative of a slight misalignment of the reed switch position transmitter (RSPT) ZT! associated with the rod bottom lights.

D. CAUSE OF THE EVENT:

1. Immediate Cause:

A reactor trip was manually initiated due to the approach of ASI to the CPC auxiliary trip setpoint.

2. Root Cause:

At the end of a fuel cycle, the effect of a decrease in plant power on ASI is greater than at any other time in the cycle. As a result, strict controls must be employed to maintain ASI within limits and prevent a trip. For this event, action was taken to control ASI, but it was not sufficient to maintain ASI within its limits. It was determined that the guidance in the operating procedure governing plant shutdown was not sufficiently specific to provide assurance that the operators could successfully control ASI during a plant shutdown at end-of-cycle.

3. Contributing Cause:

In accordance with design, the CPCs calculate core average ASI and hot pin ASI on the basis of excore detector signals that are adjusted for CEA shadowing (insertion of CEAs in the proximity of the detector), which can result in the calculated ASI to become more negative as CEAs are inserted into the core. In addition, this adjustment for CEA shadowing can cause a

disagreement between core average and hot pin ASI.

The Plant Shutdown procedure provided direction to monitor hot pin ASI when power was decreased below 20% power. As a result, the operators, who were monitoring core average ASI in accordance with procedure, were not aware that the hot channel ASI was approaching the auxiliary trip setpoint during the plant shutdown. Monitoring of the hot pin ASI at higher reactor powers may have alerted the operators sooner to the ASI problem, and additional action (including the insertion of group 5 CEAs at a higher power, the deeper insertion of the part-length CEAs, or a stoppage of the power reduction) may have been initiated which could have been sufficient to control ASI.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

An evaluation of this event was performed by the Core Analysis Engineering group as a part of the normal post trip review. As a result of this evaluation, the above causes were determined and a more detailed strategy for end-of-cycle plant shutdowns was developed.

2. Planned Corrective Actions:

a. This event will be discussed with appropriate Operations personnel.

b. The Plant Shutdown procedure will be amended to include a proper strategy for end-of-cycle plant shutdown, which will include direction to monitor hot pin ASI at higher powers and more specific guidance for ASI control.

c. Additional operator training on end-of-cycle ASI control will be included in the initial and requalification licensed training programs.

d. SCE will evaluate other alternatives to increase the ability to control ASI at end-of-cycle, including relaxing the part length CEA insertion (TS) limit and developing a

power dependent ASI limit.

e. The reed switches for CEAs #57 and #81 rod bottom lights will be inspected and repaired as necessary prior to the next plant startup.

F. SAFETY SIGNIFICANCE OF THE EVENT:

There is no safety significance to this event since the reactor protection system functioned in accordance with design.

SG inventory remained normal throughout the event, so there is no significance to the brief loss of feedwater to the SGs.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

Not applicable

2. Previous LERs for Similar Events:

LERs 85-051 and 85-060 (Docket No. 50-361) reported reactor trips due to ASI auxiliary trips of two of four CPC channels. One event occurred during a plant restart with transient xenon conditions, and the other event occurred during a planned shutdown (which induced transient xenon conditions). As a result of these events, the use of group 5 CEAs for ASI control was determined to be allowable. However, the use of group 5 CEAs is not sufficient to maintain ASI within limits or prevent a reactor trip for end-of-cycle plant shutdowns during which ASI is not closely controlled.

3. Results of NPRDS Search:

Not applicable

4. Failure of MFPT to Maintain Sufficient Discharge Pressure

The failure of the MFPT 2K006 to automatically maintain pump discharge pressure greater than SG pressure following the trip was determined to be due to the MFPT minimum control speed setting being low out of calibration. The MFPT speed controller will be calibrated during the next power ascension; this will include verification of the minimum control speed

setting to assure that adequate feedwater pressure is provided
to overcome SG pressure following a reactor trip.

ATTACHMENT 1 TO 8910120066 PAGE 1 OF 1

Southern California Edison Company

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U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Docket No. 50-361
30-Day Report
Licensee Event Report No. 89-019
San Onofre Nuclear Generating Station, Unit 2

Pursuant to 10 CFR 50.73(d), this submittal provides the required 30-day written Licensee Event Report (LER) for an occurrence involving a manual actuation of the Reactor Protection System. This occurrence had no effect on the health and safety of either plant personnel or the public.

If you require any additional information, please so advise.

Sincerely,

Enclosure: LER No. 89-019

cc: C. W. Caldwell (USNRC Senior Resident Inspector, Units 1, 2 and 3)

J. B. Martin (Regional Administrator, USNRC Region V)

Institute of Nuclear Power Operations (INPO)

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